FIRST QUARTERLY TECHNICAL PROGRESS REPORT

ALKALI METAL RESISTANT ELECTRICAL DEVICES

USAF CONTRACT AF33(615)-3528
BUDGET NO. (BPSN) 6(638128 62405214)

OCTOBER 15, 1966
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Westinghouse
ELECTRIC CORPORATION
AEROSPACE ELECTRICAL DIVISION
LIMA, OHIO

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(June 20, 1966 - September 25, 1966

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FOREWORD

This first Quarterly Report is submitted by the Aerospace Electrical Division, Westinghouse Electric Corporation, Lima, Ohio, on Air Force Contract AF33(615)-3528, Budget No. (BPSN): 6(638128 62405214) Alkali Metal Resistant Electrical Devices. The contract is administered by the Air Force Aero Propulsion Laboratory, Research and Technology Division, Wright Patterson Air Force Base, Dayton, Ohio. Mr. Lester Schott is Project Engineer for APIP on this contract.

The work described in this report was done by personnel in the Materials Development and Research and Development Groups of Westinghouse Aerospace Electrical Division, Lima, Ohio. The engineers and their areas of responsibility, in which they contributed are as follows: N. K. Harpster - Circuit Design, A. J. Krause - Test Engineering and Mechanical Design, R. E. McVay - Metallurgical Studies, J. W. Ogden - Transformer Design, and R. E. Stapleton - Ceramic Technology.

ABSTRACT

This report covers progress during the first quarter on Air Force Contract AF33(615)-3528. The materials proposed for evaluation in 600°C potassium vapor are on order.

Designs of potassium corrosion test capsules and continuous material degradation test capsules were completed. The capsules are currently being constructed from potassium resistant materials.

The electrical design of a 5 KVA test transformer has been completed and component parts such as laminations, conductors, and insulators are being fabricated.

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SECTION I

INTRODUCTION

This report covers the first quarter from 20 June 1966 to 25 September 1966 on Air Force Contract AF33(615)3528, Alkali Metal Resistant Electrical Devices.

This program involves the study and evaluation of electrical device materials for 600°C, 5000 hour, potassium vapor operation. Conductors, insulators, and magnetic materials capable of being used in potassium vapor exposed electrical circuits will be exposed to 600°C potassium vapor for times up to 5000 hours. Positive identification of degradation over this time period will be established with the goal of providing materials compatible with environmental test conditions. Processes and techniques necessary to insure mechanical and electrical compatibility and integrity of metal to metal and ceramic to metal interfaces will be investigated. The goal is to provide processing techniques for potassium vapor resistant electrical device fabrication. Transformers rated at 5 KVA will be fabricated and results of electrical tests in ionized and non-ionized 600°C potassium vapor will be evaluated.

SECTION II

SUMMARY OF WORK PERFORMED AND MAJOR RESULTS

A. MATERIALS FOR 600°C POTASSIUM VAPOR EXPOSURE

Work was begun toward the evaluation of potassium vapor exposure on electrical device materials.

1. Potassium Vapor Exposure Specimens

Potassium vapor exposure specimens were ordered.

2. Modulus of Rupture Test Fixture

A modulus of rupture test fixture was designed and fabricated.

3. Potassium Vapor Test Capsules

Potassium vapor exposure test capsule material was ordered. Stainless steel was received and capsules fabricated from this material.

4. Test Capsule Containers

Test containers for potassium vapor exposure capsules were designed and fabricated.

5. Rowland Rings

Rowland rings for magnetic tests in potassium vapor were designed and punched.

6. Core Box

A ceramic and metal core box was designed to contain Rowland rings and potassium vapor during magnetic testing. Metal for core box construction was obtained.

7. Conductor Performance Test Container

A container for continuously monitoring conductor performance was designed and partially fabricated.

B. PROCESSES AND TECHNIQUES FOR POTASSIUM VAPOR RESISTANT ELECTRICAL DEVICE FABRICATION

Work was begun on processes and techniques for fabricating potassium vapor resistant electrical devices.

1. Plasma Spray Ceramic Insulation and Binder Material

Plasma spray insulations were ordered. Binder material for ceramic/metal interface evaluation was procured. Alumina (99.99%) was plasma sprayed on Hiperco 27 alloy substrates and preliminary evaluation made.

2. Radio Frequency (R.F.) Sputtering

Alumina (99.9%) was sputtered as an interlaminar insulation on Hiperco 27 alloy substrates.

3. Alumina-Yttria Eutectic

Alumina yttria ceramic bodies (82 mole % Al_2O_3 - 18 mole % Y_2O_3) were prepared.

4. Ceramic/Metal Interface Capsules

Material for ceramic/metal interface-potassium vapor exposure capsule was ordered.

C. DESIGN AND FABRICATION OF THE 5 KVA TRANSFORMERS

1. Transformer Design

The electrical design of the 5 KVA transformer was completed. Magnetic laminations, electrical conductors, and ceramic insulation were designed.

2. Ceramic to Metal Electrical Feedthroughs

Ceramic to metal electrical feedthroughs were ordered.

3. Active Metal Braze Materials

Active metal braze materials, Nicrobraz 130 and 51.7 w/o Ti - 31.6 w/o Ni - 16.7 w/o Cb, were procured.

D. POTASSIUM CAPSULE HANDLING

An inert atmosphere glove box for use in loading specimens and potassium was checked and found capable of operating with an atmosphere of argon gas containing less than 5 ppm combined oxygen and moisture. The glove box was equipped for capsule evacuating and sealing.

SECTION III

EXPERIMENTAL WORK

A. EVALUATION OF ELECTRICAL DEVICE MATERIALS IN POTASSIUM VAPOR

1. General Description

Various magnetic materials, electrical conductors, and insulation materials will be exposed to 600°C potassium vapor for various times through 5000 hours and evaluated to determine degradation. The potassium used for the tests will contain not more than 25 ppm of O_2. Materials will be tested in quadruplicate and will be evaluated:

(a) Prior to potassium vapor exposure.

(b) After 1000 hours in 600°C potassium vapor.

(c) After 2000 hours in 600°C potassium vapor.

(d) After 3000 hours in 600°C potassium vapor.

(e) After 5000 hours in 600°C potassium vapor.

Magnetic materials and electrical conductors will be subjected to tensile testing and visual and metallographic examinations. Ceramic bar materials will be subjected to modulus of rupture tests, weight change determinations, and microscopic examinations. A four point modulus of rupture test fixture for ceramic bars was designed and built, and is described in Figure 1. Sapphire mat materials will be subjected to microscopic examinations and any weight changes determined.

2. Potassium Vapor Exposure Test Specimens

Table I lists materials which will be potassium vapor tested and indicates capsule material and supplier. The following materials have been ordered:

(a) Rhodium wire, 0.030 ± 0.002 inch diameter.

(b) Iridium wire, 0.030 ± 0.002 inch diameter.

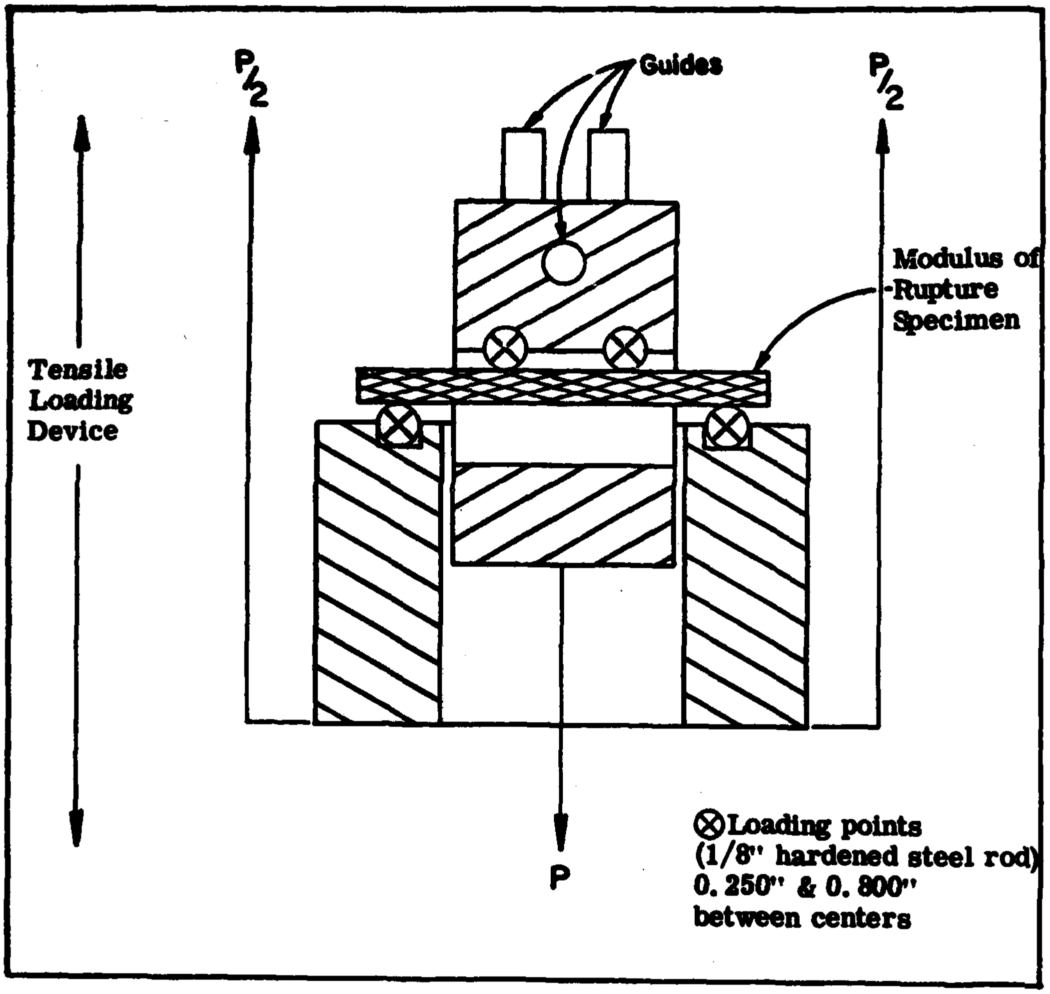


FIGURE 1. Modulus of Rupture Four Point Loading Fixture

TABLE I

POTASSIUM VAPOR EXPOSURE MATERIALS

	Test Material	Source	Capsule Material
Conductors	1. Iridium (wire) 2. Rhodium (wire) 3. Nickel Clad Silver (wire) 4. Inconel Clad Silver (wire)	1. Englehard Ind., Newark, N.J. 2. Sigmund Cohn Corp., Mt. Vernon, N.J. 3. Sylvania Parts Div., Warren, Pa. 4. Sylvania Parts Div., Warren, Pa.	Columbium -1% Zirconium
Insulators	5. Alite A-610 (Bar) (99%Al_2O_3-1% MgO) 6. SrO.ZrO_2 (Bar 7. AD998 (Bar) (99.8% Al_2O_3-0.2%MgO) 8. $Al_2O_3 \cdot Y_2O_3$ (Bar) 9. Sapphire (felt) (99.99%Al_2O_3) 10. Sapphire (felt) +$Al(OCl)_n$ 11. BeO (Bar) (99.8% BeO)	5. U.S. Stoneware, Akron, Ohio 6. Westinghouse Electric Corp. Lima, Ohio 7. Coors Procelain Co., Golden, Colo. 8. Westinghouse Electric Corp. Lima, Ohio 9. Thermokenitic Fiber Inc. Nutley, New Jersey 10. Thermokenitic Fiber Inc. Nutley, New Jersey and Westinghouse Electric Corp. Lima, Ohio 11. Brush Beryllium Co., Elmore, Ohio	Stainless Steel Type 347 (AMS 5571)
Magnetic Materials	12. Hiperco 27 Alloy (strip) fully annealed 13. Cubex (strip) fully annealed	12. Westinghouse Electric Corp. Blairsville, Pa. 13. Westinghouse Electric Corp. Pittsburgh, Pa.	Columbium -1% Zirconium

(c) Ceramic modulus of rupture bars (see Figure 2).

(d) Sapphire whisker mats, 0.010 inch thick.

The following materials have been procured:

(a) Nickel clad (20%) - silver wire, AWG No. 10 round.

(b) Inconel 600 clad (20%) - silver wire, 0.093 inch by 0.156 inch.

(c) Hiperco 27 alloy, 8 inch by 0.25 inch by 0.008 inch (see Figure 3)

(d) Cubex, 8 inch by 0.25 inch by 0.008 inch (see Figure 3).

Table II gives the result of a series of tensile tests on Cubex and Hiperco 27 alloy.

Table III gives the chemical composition and specification for the 0.008 inch thick Hiperco 27 alloy to be used throughout this program.

3. <u>Test Capsules and Containers</u>

Test capsules have been designed, see Figure 4. These capsules will be made of columbium-1% zirconium or 347 stainless steel tubing as these materials have demonstrated potassium resistance.[1 (a)] Stainless steel tubing will be used for testing insulator materials as they do not have elements common to the stainless steel. Columbium-1% zirconium will be used for the remaining material's capsules. Capsules were designed to have both liquid and vapor regions with a perforated plate of the capsule material separating the two regions.

Stainless steel capsule material in the form of tubing was received, cut to capsule length, and pre-cleaned according to the following schedule:

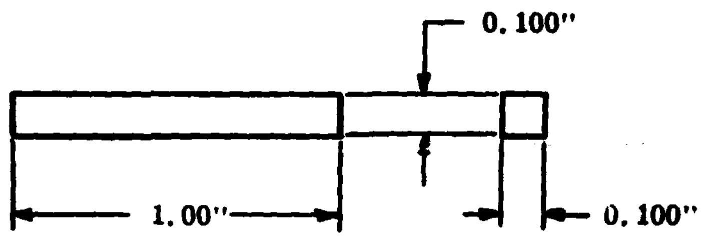
(a) Ultrasonic clean in water-detergent solution.

(b) Rinse in distilled water.

(c) Rinse in petroleum ether.

(d) Rinse in acetone.

(a) Numbers refer to references at end of report.



Opposite sides shall be parallel within 0.001.

Tolerances:

Length ± 0.010

Other Dimensions ± 0.001

All surfaces shall be diamond ground.

FIGURE 2. Modulus of Rupture Ceramic Specimen Bar

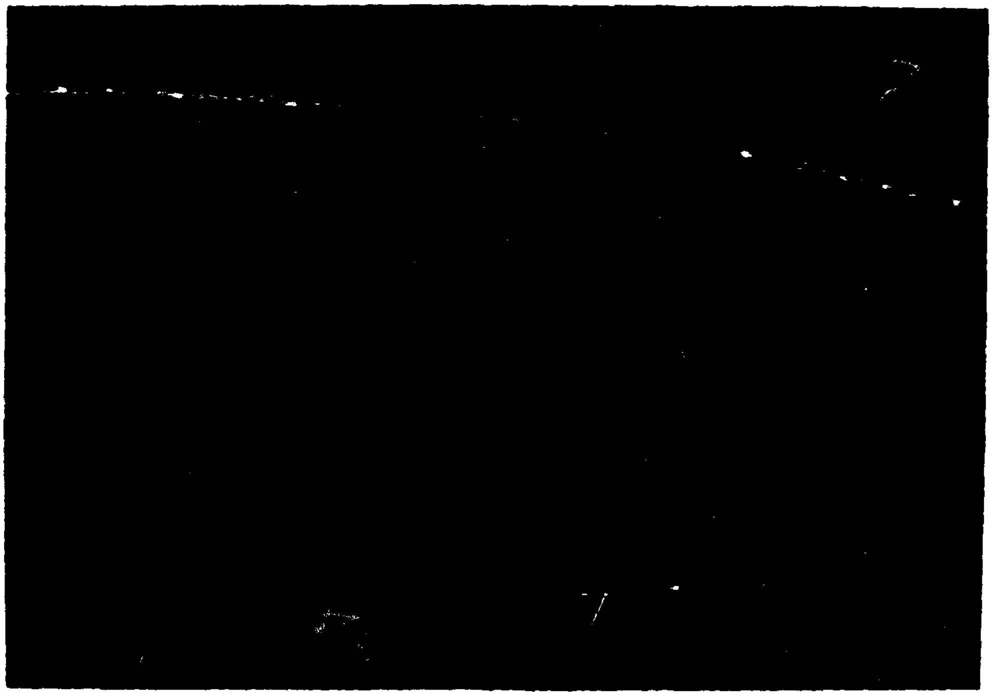


FIGURE 3. Magnetic Material Potassium Vapor Exposure Specimens

TABLE II

TENSILE PROPERTIES OF AS-RECEIVED HIPERCO
27 ALLOY AND CUBEX

Procedure:

Test samples were tested in an Instron tensile tester using air grip jaws and a cross head movement rate of 0.005"/min. with the exception of one sample which was tested at a rate of 0.1"/min.

Test Results:

Material: Cubex (Annealed)

Sample No.	Yield (0.2% offset)	Ultimate Strength (psi)
1	40,145	49,300
2	41,400	50,700
3	40,441	49,750
4	40,100	50,600
5 (a)	40,441	50,367

Material: Hiperco 27 Alloy (As Cold Rolled)

Sample No.	Yield (0.2% offset)	Ultimate Strength (psi)
1 (b)	85,250	122,300
2 (c)	85,300	153,200
3 (c)	89,500	125,000
4 (b)	85,250	122,300

(a) Cross head movement rate of 0.1 inch/min.
(b) Sample No. 1 & 4 failed in jaws.
(c) Sample No. 2 & 3 failed at edge of jaws.

TABLE III

CHEMICAL ANALYSIS OF 0.008 INCH HIPERCO 27 ALLOY

Heat No. HO 8084

Element	Specification (%)	Analysis (%)
N	0.70 max.	0.08
S	0.025 max.	0.0056
Si	0.25 max.	0.17
Mn	0.50 max.	0.33
C	0.020 max.	0.020
Co	26.00-28.50	27.8
Cu	-	< 0.10
P	0.015 max.	0.003
Cr	0.30-0.70	0.59
Fe	Balance	-

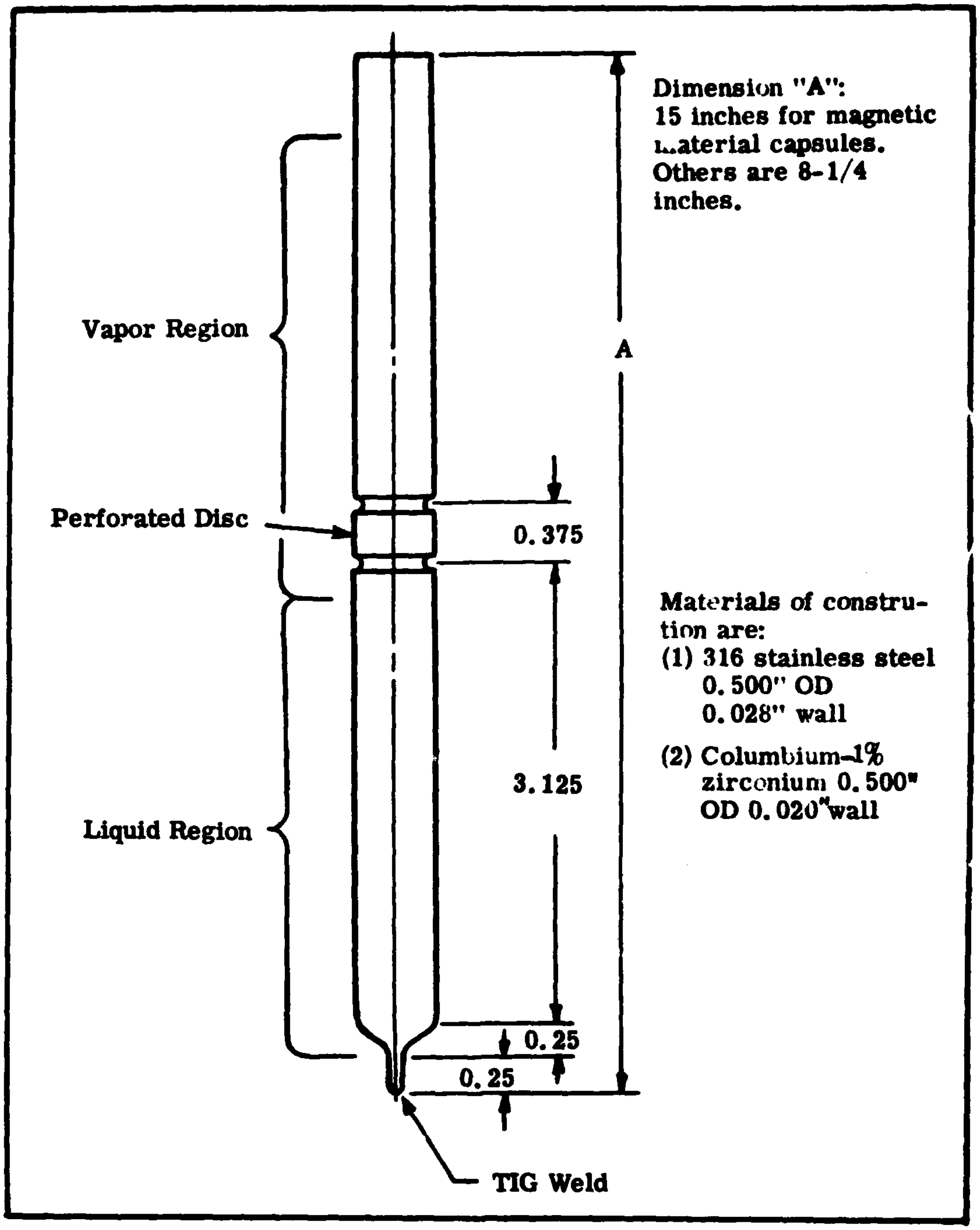


FIGURE 4. Test Capsule for Potassium Vapor Exposure Capsule

(e) Dry in an oven at 150°F for 60 minutes.

Subsequent to pre-cleaning, the ends of the tubes were crimped and closed by welding. Each weld was then tested for leaks, using a CVC helium leak detector and all were found to be leak tight.

Capsules were then recleaned according to the following:

(a) Pickle for 2 hours in 10:1 H_2SO_4-HNO_3 at 80°C.

(b) Rinse in distilled water.

(c) Rinse in chemically pure acetone.

(d) Oven dry. (150°F for 60 minutes)

One of these capsules is shown in Figure 5.

Columbium-1% zirconium capsule tubing and perforated sheet have been ordered.

Rowland rings for testing in potassium vapor have been punched. Figure 6 shows these rings. The core box for potassium vapor testing of Rowland rings has been designed and materials ordered.

Figure 7 shows the core box configuration with bottom and sides made of 0.030 inch thick columbium-1% zirconium sheet electron beam welded together. The potassium fill tube is 0.50 inch OD with 0.020 inch thick wall and is TIG welded to the outer cylinder. The remaining side contains a ceramic which breaks the electrical and magnetic circuit around the core box.

The container for continuously monitoring conductor performance in potassium vapor has been designed and partially completed. Figure 8 shows the basic container and top plate of 316 stainless steel minus ceramic-to-metal insulating terminals and potassium fill tube.

Stainless steel type 316 containers which will contain potassium vapor exposure capsules have been designed and fabricated. Capsules of stainless steel and columbium-1% zirconium will be wrapped with tantalum foil and sealed in these containers. Figure 9 shows two of the capsule test containers.

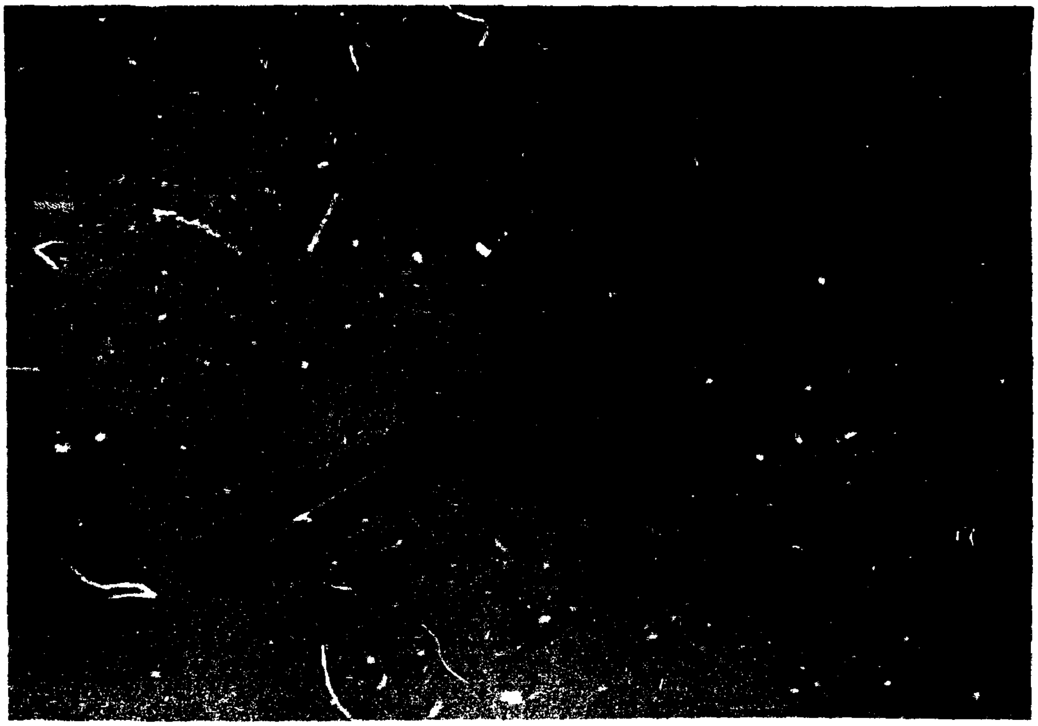


FIGURE 5. Stainless Steel Test Capsule Prior to Loading of Potassium

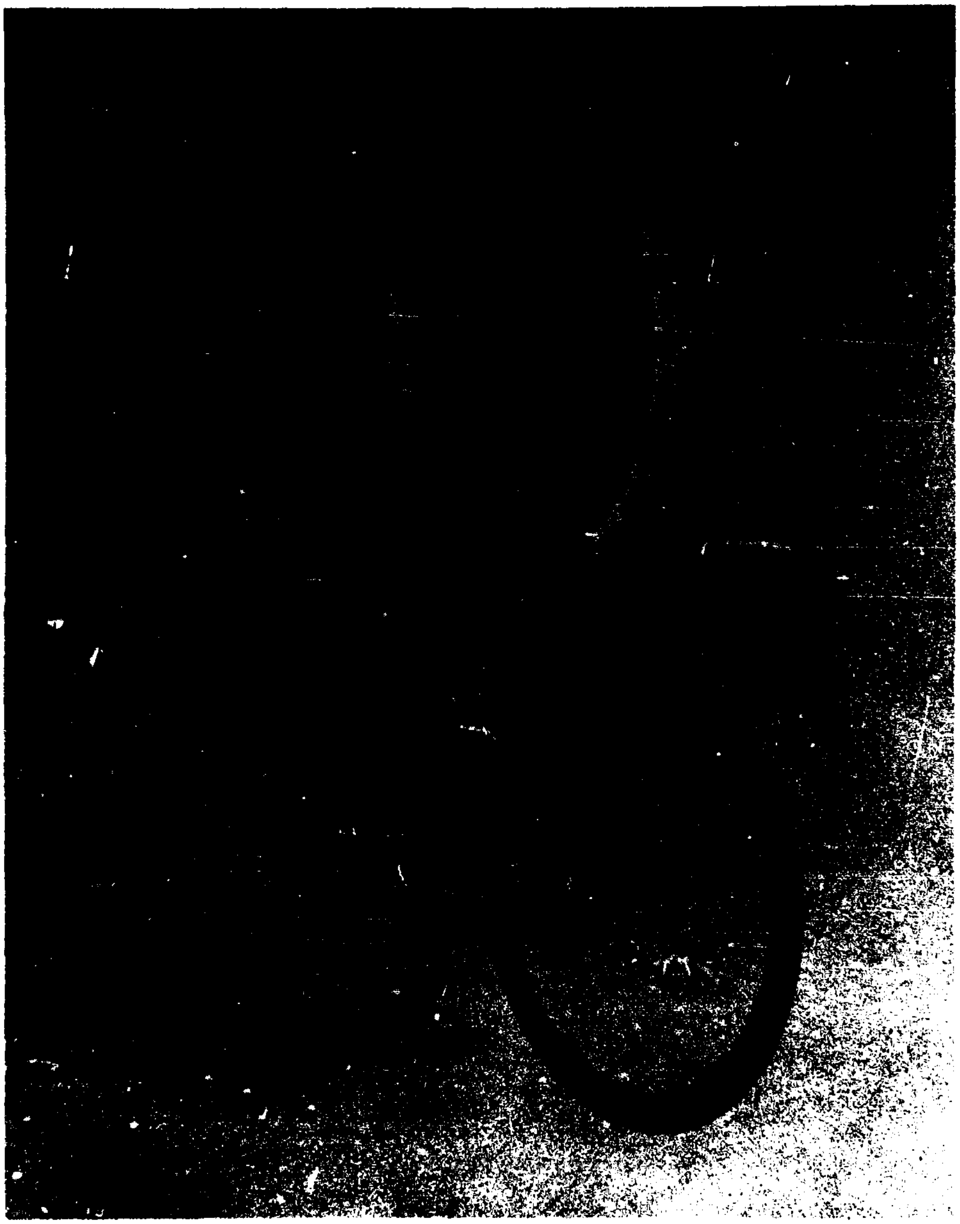


FIGURE 6. Hiperco 27 Alloy Rowland Rings 0.008 Inch Thick

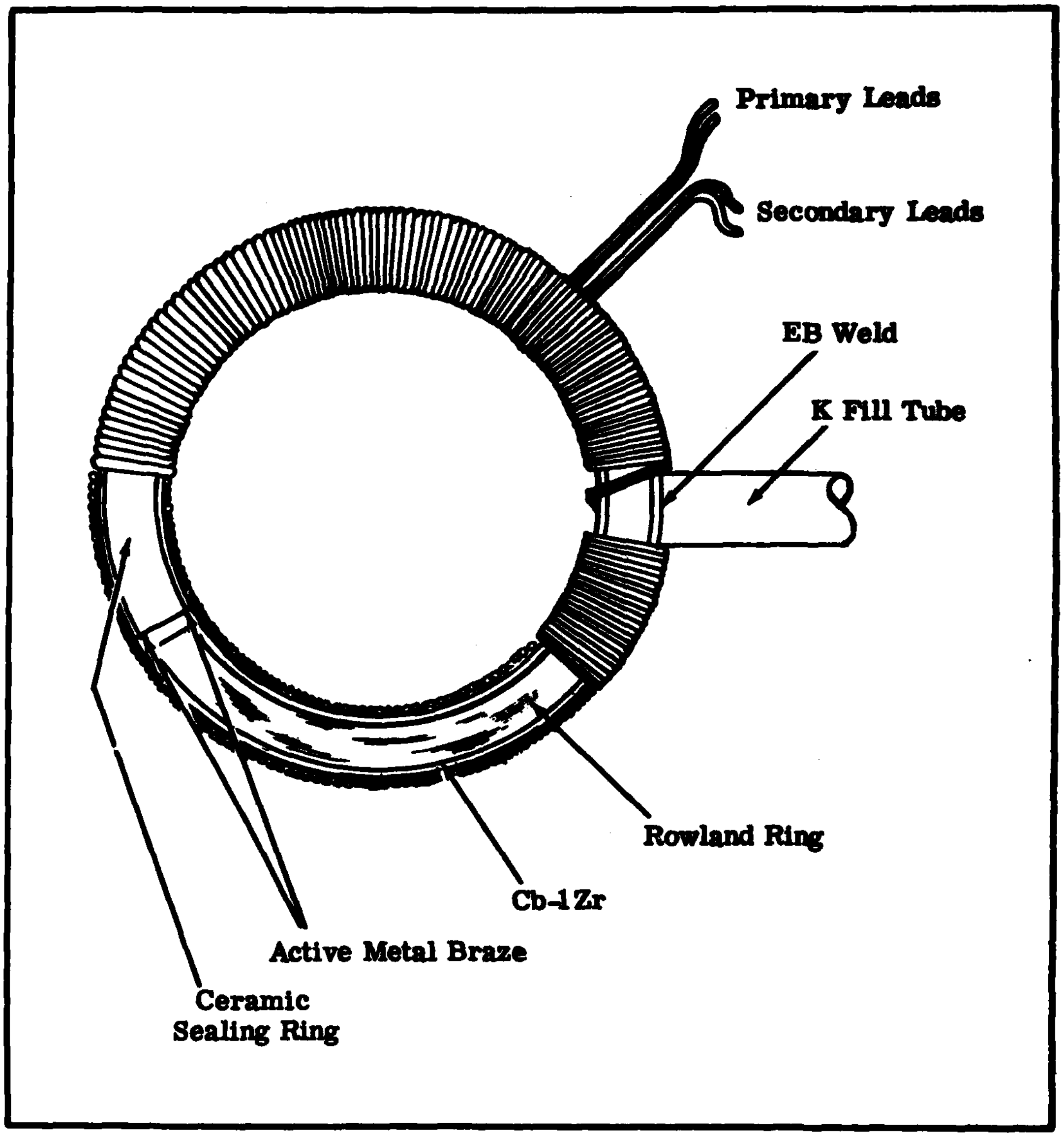


FIGURE 7. Rowland Ring Core Box

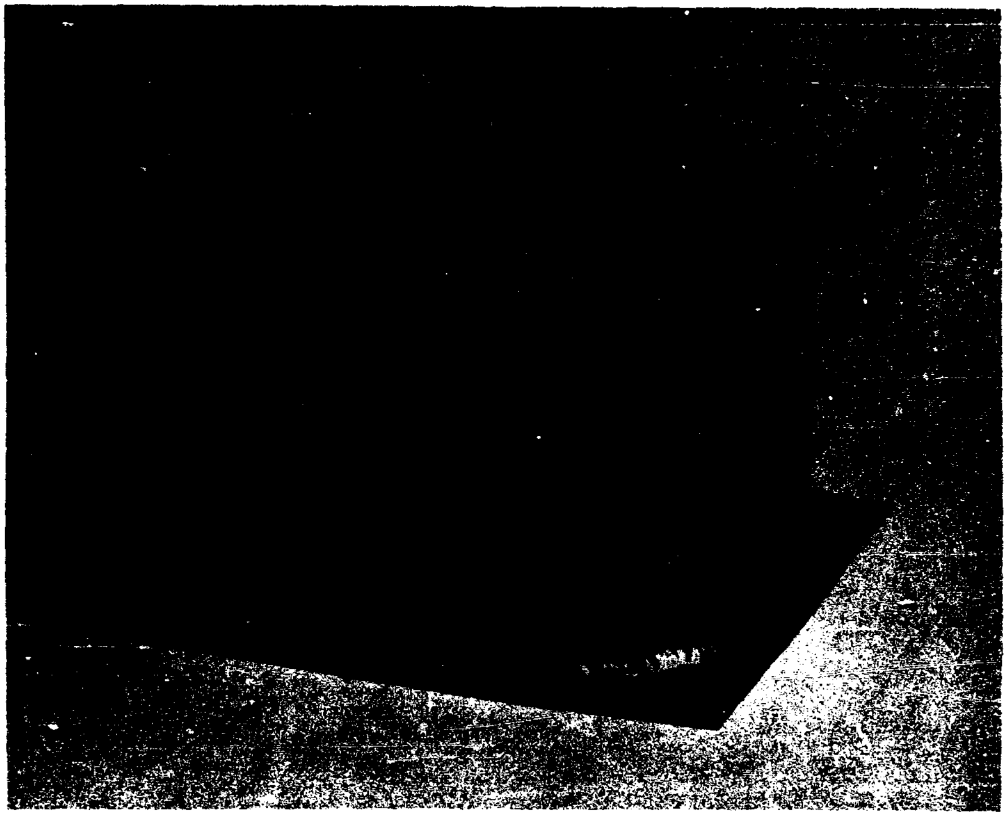


FIGURE 8. Conductor Continuous Measurement Container
Type 316 Stainless Steel

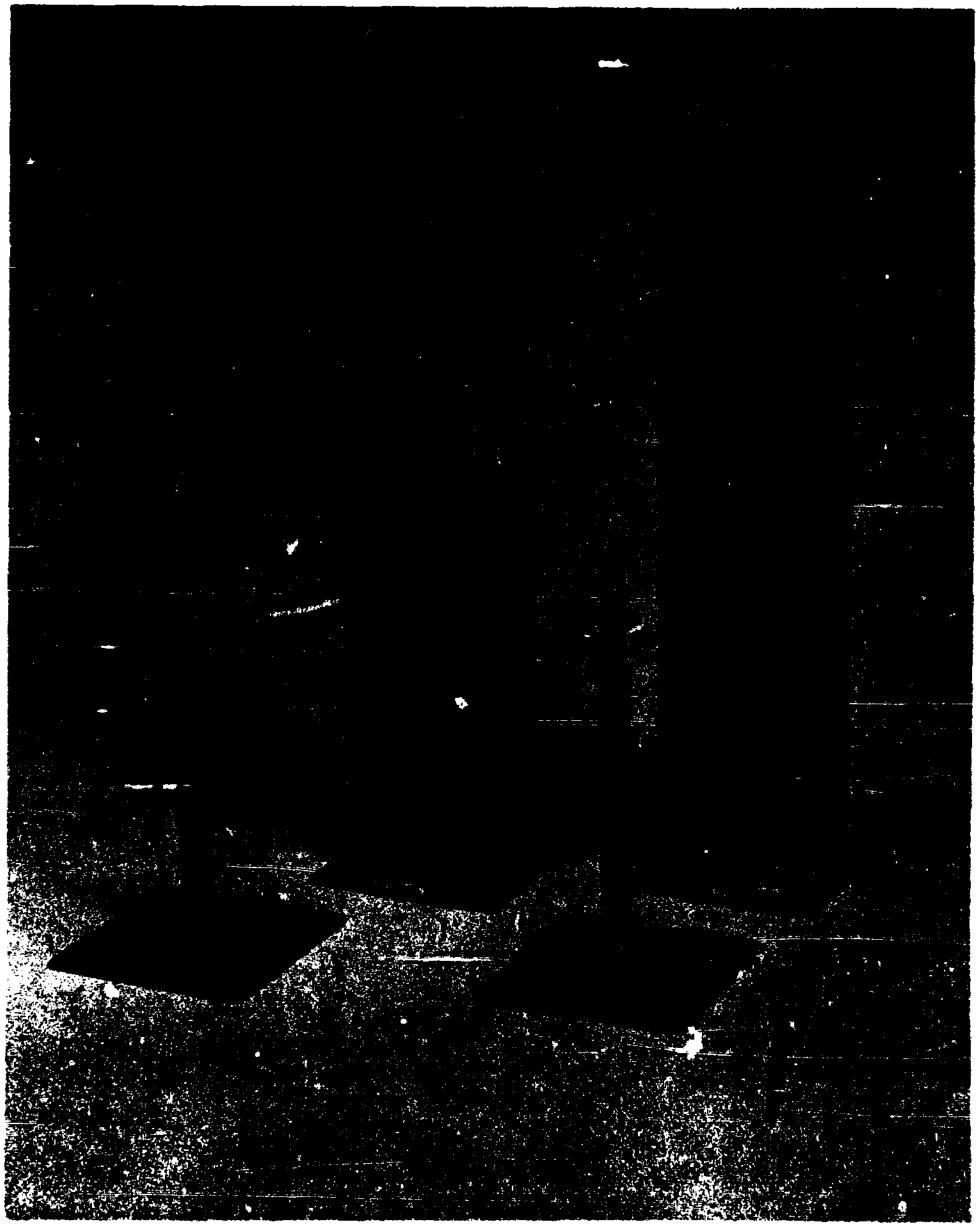


FIGURE 9. Stainless Steel Test Containers for Potassium Vapor Exposure Capsules

B. PROCESSING TECHNIQUES AND MATERIALS

1. General Description

Several materials and combinations of materials, applied in various ways, are being investigated as potassium vapor resistant electrical insulation for conductor and interlaminar applications. High alumina materials, alumina-yttria eutectic, and strontium zirconate will be either sprayed, radio frequency (R.F.) sputtered, or slip coated and fired on conductor or metal substrates. The substrates will include Inconel 600, nickel, rhodium, iridium, and Hiperco 27 alloy. Nickel aluminide and titanium will be evaluated as a binder between the metal and the various ceramic insulations.

2. Plasma Sprayed Insulation and Binder Materials

Plasma sprayed samples of Linde A on Hiperco 27 alloy have been prepared. DC resistance of one coated sample was measured at room temperature and under room ambient conditions (72°F, 68% R.H.) for a 3-mil thick coating of Linde A. A Kiethly Electrometer (Model 610B) and Regulated DC Power Supply (Model 240) was used. Mercury was used as the counter-electrode and was confined to a known diameter (1.24 cm) with a plastic tube. The coating thickness was measured in cross section at 30X magnification with a calibrated reticule after testing was completed.

The results obtained by use of this mercury electrode for measuring d-c breakdown are interesting as a continual decrease in electrical breakdown was observed over approximately a 60 minute time period. The initial breakdown was 370V dc/mil, decreasing to 230V dc/mil. A calculated d-c resistivity value of 4.57×10^{10} ohm-cm was obtained from the electrode area and coating thickness measurements.

Ceramic material, 99% Al_2O_3-1% MgO and 99.99% Al_2O_3, for plasma sprayed conductor insulation has been ordered and the latter type received. Nickel aluminide and titanium hydride binder material for ceramic/metal interface evaluation has been procured.

3. Radio Frequency (R.F.) Sputtering

High-purity alumina was R.F. sputtered on a Hiperco 27 alloy substrate using a CVC AST200 R.F. Sputtering Power Supply (see Figure 10). The power supply was used to energize a dielectric target. The overall configuration of the target and associated fixturing is shown in Figure 11.

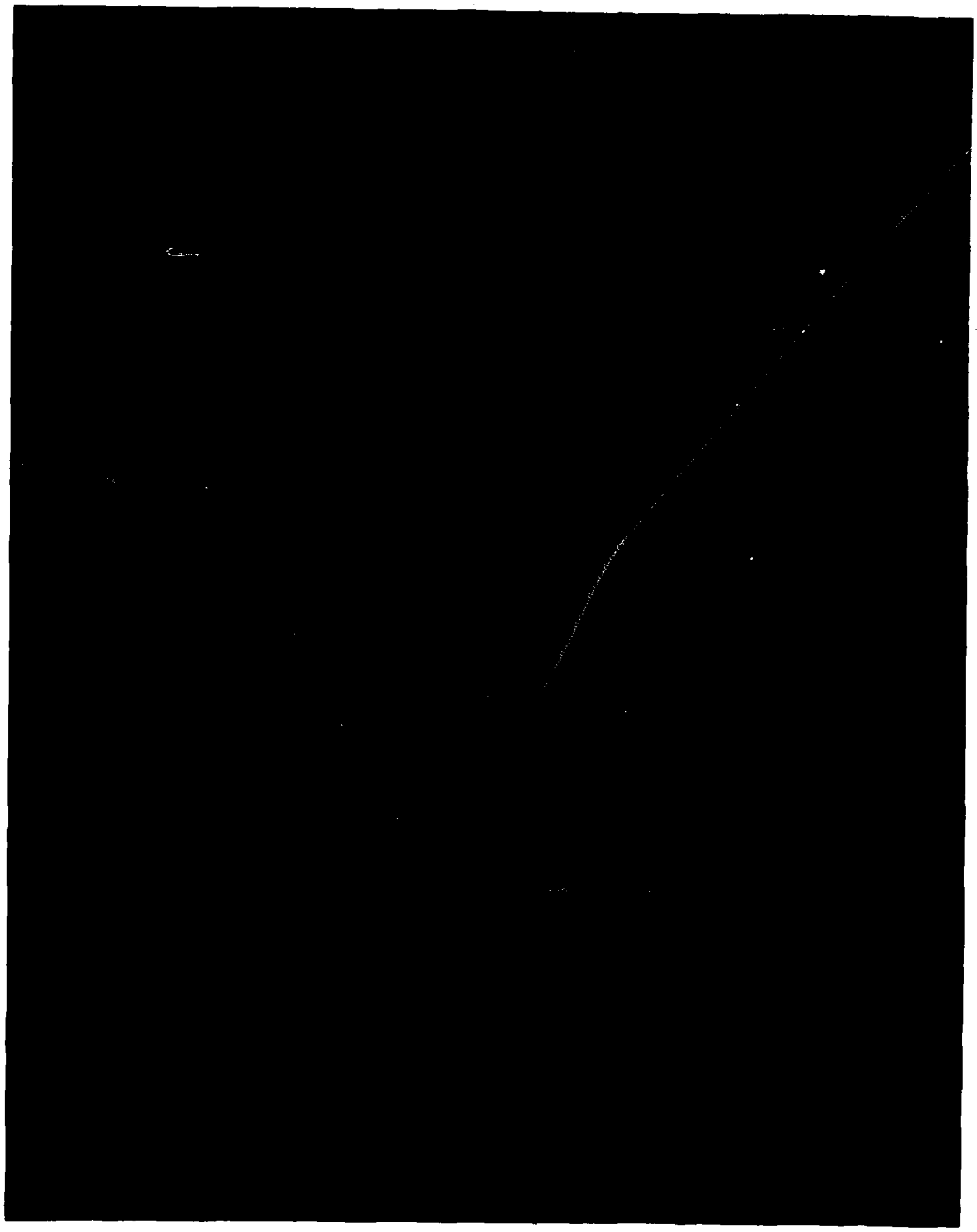


FIGURE 10. R. F. Sputtering Power Supply

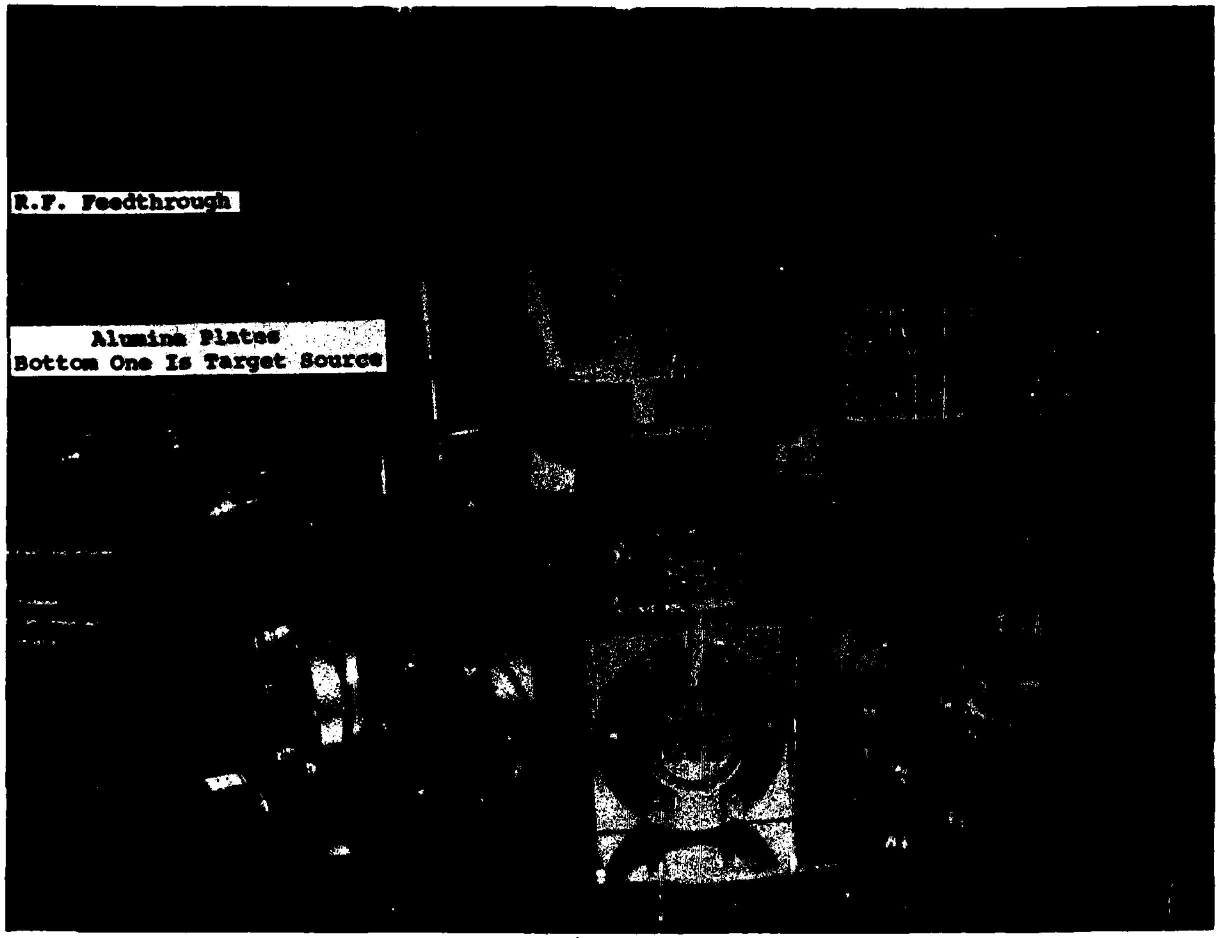


FIGURE 11. R. F. Sputtering Apparatus Using Diode Target Geometry

The target consists of two disks (4.0 inches in diameter) of high purity alumina (Triangle RR, 99.7% Al_2O_3). A "fired on" platinum electrode was applied to the lower disk (Figure 11) and aluminum foil was used to make electrical contact to the platinum electrode and a R.F. feed-through. R.F. power at 13.56 Mc/sec was applied to the platinum electrode which produced a negative bias voltage on the opposite surface of the alumina target.

The vacuum chamber (glass bell jar) was first evacuated to 10^{-6} torr and then, during sputtering, backfilled with argon to a pressure in the range from 5 to 7 microns. An argon plasma was then created in the region of the target by application of R.F. energy. A current in the range from 5 to 8 amperes was circulated in a coil located around the bell jar which produced a magnetic field to confine the argon plasma (increased the plasma density) and hence increased the sputtering rate. The negative bias voltage on the surface of the dielectric accelerated the positive argon ions toward the target (alumina) and the sputtering action was initiated. Deposition rates of about 100 Å/minute are typical with this arrangement at its present state of refinement. Several preliminary coatings of Al_2O_3 were prepared on Hiperco 27 alloy substrates with "as received" surfaces. These coatings were about 6000 Å thick. Results to date indicate that the surfaces of Hiperco 27 alloy will have to be smoothed by an etching or chemical polishing technique to insure uniform insulating properties over the entire surface. A chemical polishing solution consisting of HNO_3 and HF has shown considerable promise.

4. <u>Alumina - Yttria Eutectic</u>

Alumina-Yttria eutectic is being investigated as a slip cast and fired insulation for rhodium and iridium wire, and as a castable ceramic insulation. Aluminum oxide-yttrium oxide eutectic consists of 82 mole percent Al_2O_3 and 18 mole percent Y_2O_3.[2] Melts were prepared from the following raw materials.

(a) Al_2O_3 - Linde A (0.3μ) Crystal Products, Linde Division, Union Carbide Corp.

(b) Y_2O_3 - Code 11116 Trona Chemicals, Rare Earth Division, American Potash and Chemical Corporation.

The eutectic was mixed with de-ionized water in an alumina (~ 94% Al_2O_3) motor driven mortar and pestle (1/2 hour mixing time). This approach was used only to prepare preliminary small batches (< 50 grams). Ball milling in a high alumina mill (99+%Al_2O_3) will be the basic method used to prepare subsequent material for further evaluation.

After mixing, the slurry was poured into a graphite crucible and dried in an oven at 150°C for one hour. Several initial experiments (< 30 grams) with induction heating in a flowing argon atmosphere demonstrated that the material could be melted satisfactorily at a temperature of approximately 1870°C (measured with an optical pyrometer). Each melted button was dark grey and contained numerous trapped air pockets.

Approximately 30 grams of raw materials was melted (graphite container) in the oil diffusion pumped cold wall vacuum furnace having a liquid cooled baffle(shown in Figure 12). The furnace temperature was increased to 1870°C and held at this temperature for 1/2 hour at a pressure of approximately 1×10^{-4} torr. On cooling, it was apparent that the material had crystallized into a mass of rather large crystallites. A photomicrograph of the button surface is shown in Figure 13 and photograph of the entire disc is shown in Figure 14. The vacuum melted material shows a significant improvement in color and overall microstructure (no visible voids or air pockets) over the one that was melted in argon using induction heating.

5. Ceramic/Metal Interface Capsules

Capsules for ceramic/metal interface evaluations have been designed and are identical to the shorter capsules in Figure 4, Section III.A.3. Capsule material consisting of 0.500 inch outside diameter, 0.028 inch wall, 347 stainless steel tubing and 316 stainless steel perforated plate has been ordered.

C. DESIGN AND FABRICATION OF 5 KVA TRANSFORMER

1. Transformer Design

The 5 KVA transformer for this program has been designed and magnetic material ordered. The magnetic material is 0.008 inch thick Hiperco 27 alloy in the E and I configuration shown in Figure 15. The transformer height will be 2-1/4 inches with a 0.85 or better stacking factor.

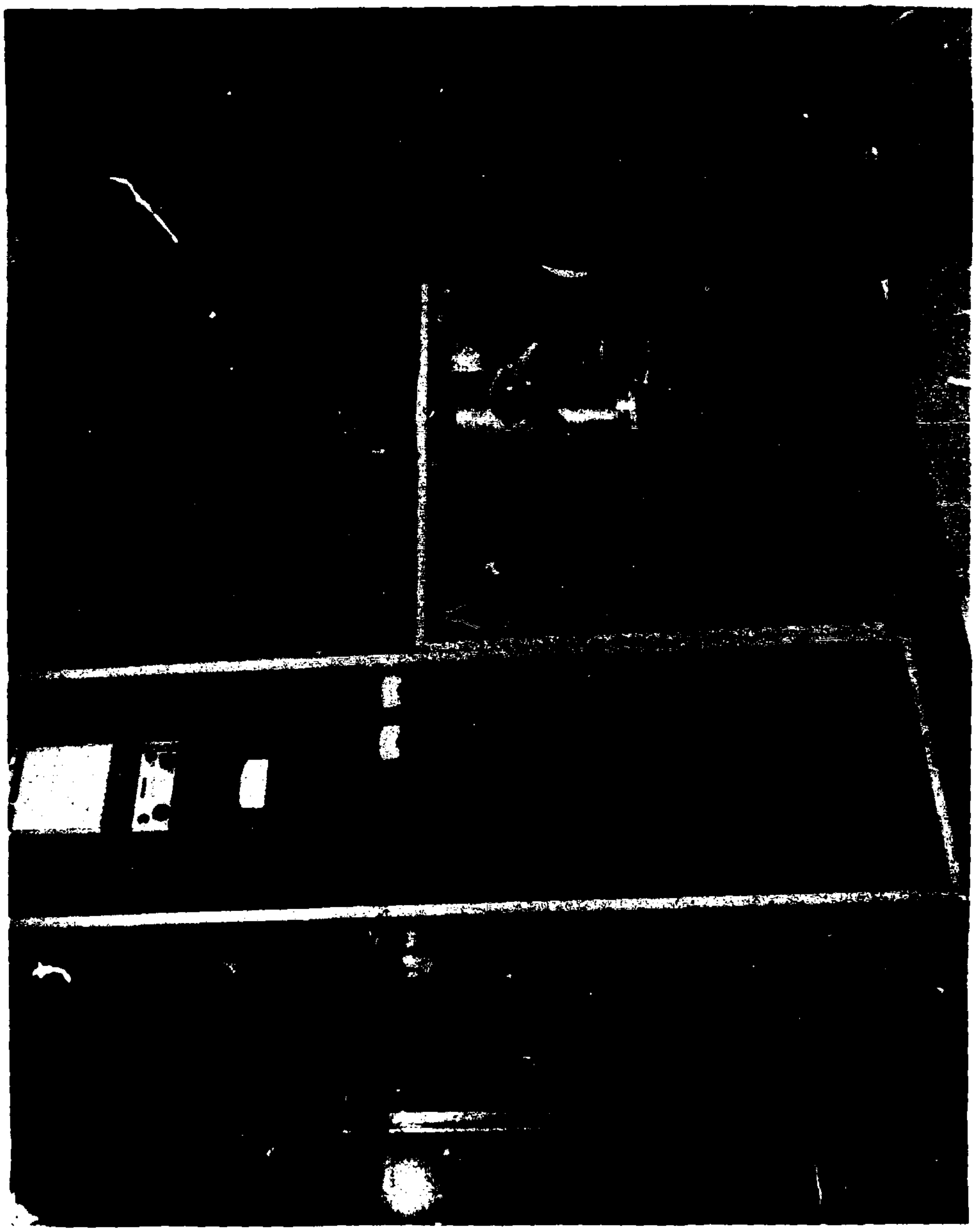


FIGURE 12. Cold Wall 3000°C Vacuum Furnace

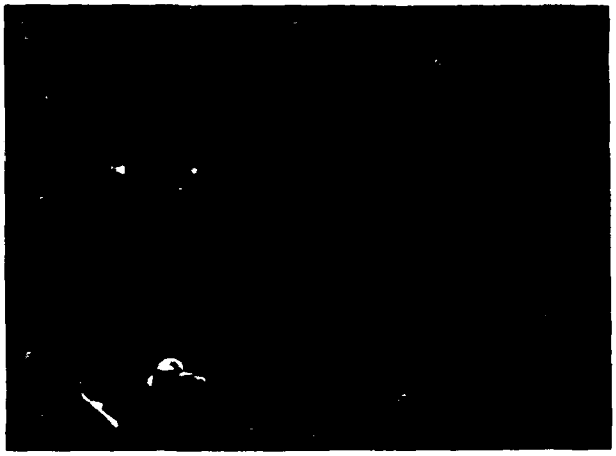


FIGURE 13. Alumina-Yttria Microstructure

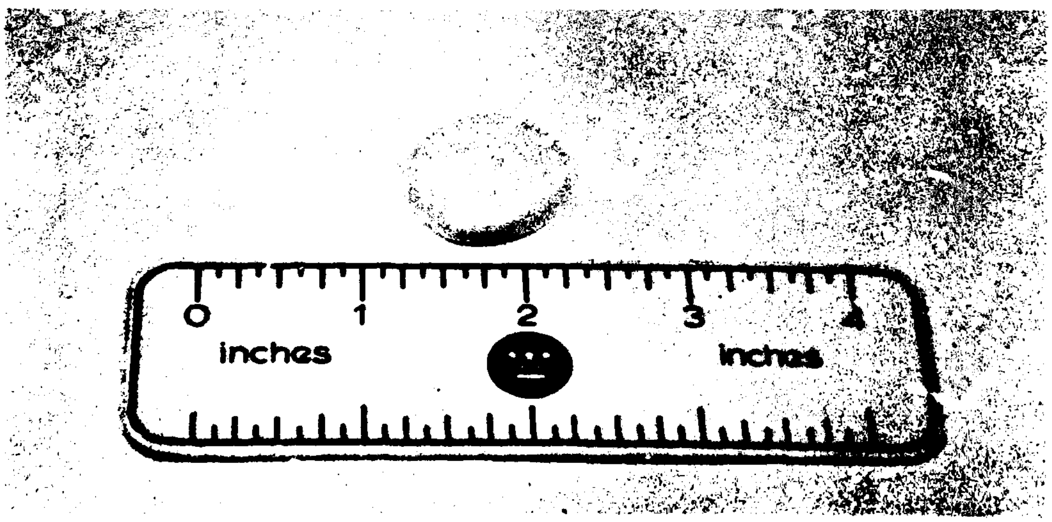
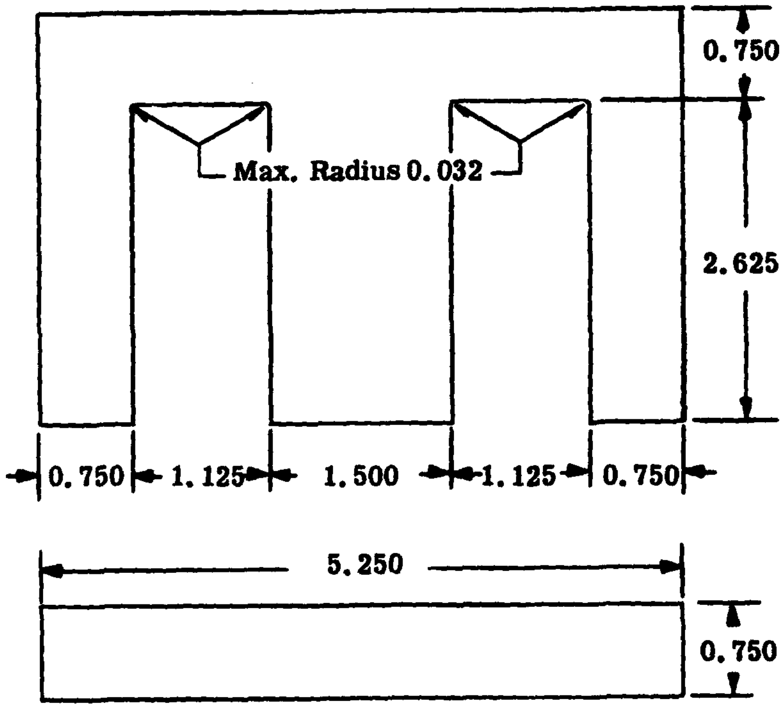


FIGURE 14. Vacuum Melted Alumina-Yttria Disc



Dimension Tolerance: ± 0.002 inches

Material: Hiperco 27 (PDS 13202 AC) Alloy thickness 0.0008 inch

FIGURE 15. Five KVA Transformer EI Laminations

Electrical conductors will be 0.081 inch by 0.129 inch rectangular wire consisting of a silver core clad with 20 percent Inconel 600 or nickel. Two of these conductors, electrically in parallel and physically located in a two-high arrangement will be used in both the primary and secondary windings. Both primary and secondary windings will take two rows with 26 and 27 turns respectively. Interturn insulation will consist of thin pieces of 99% Al_2O_3 -1% MgO between turns with a layer of the same material plasma sprayed between rows. A coil form of this material will insulate the conductors from the magnetic material core and hold the windings as an integral unit. Figure 16 shows a conceptual view of this transformer.

2. Ceramic-To-Metal Feedthroughs

Ceramic-to-metal electrical feedthrough seals have been designed and 20 have been ordered. Figure 17 shows the ceramic-to-metal seal configuration. These seals will be used in test transformer containers and in the continuously monitored conductor performance container.

3. Active Metal Braze Materials

Active metal braze containing the following nominal weight percentages was procured: titanium, 51.7; nickel, 31.6; and columbium, 16.7. This material is to be used to join various ceramic materials to metals in potassium vapor resistant devices such as the core box described in Section III.A. and Westinghouse made electrical feedthroughs.

A commercial braze alloy Nicrobraz 130 was obtained from Wall Comony Corporation to be used in joining columbium -1% zirconium to stainless steel.

D. POTASSIUM CAPSULE HANDLING

A glove box will be used for loading potassium vapor exposure specimens into test capsules and potassium into test devices such as Rowland ring core boxes and 5 KVA transformer test containers. This glove box and gas purification system has demonstrated the ability of operating at less than 5 ppm combined oxygen and moisture. The glove box is equipped with a vacuum system with which capsules and other potassium loaded devices can be evacuated. The pumping portion of evacuation system consists of three Varian Vac Sorb (TM) roughing pumps and a 115 liter/sec ion pump. The glove box is also equipped with a hydraulic fixture to crush and crimp 0.500 inch potassium loaded tubes and TIG welding equipment to cut and seal these tubes. Figure 18 shows the glove box and capsule evacuation equipment.

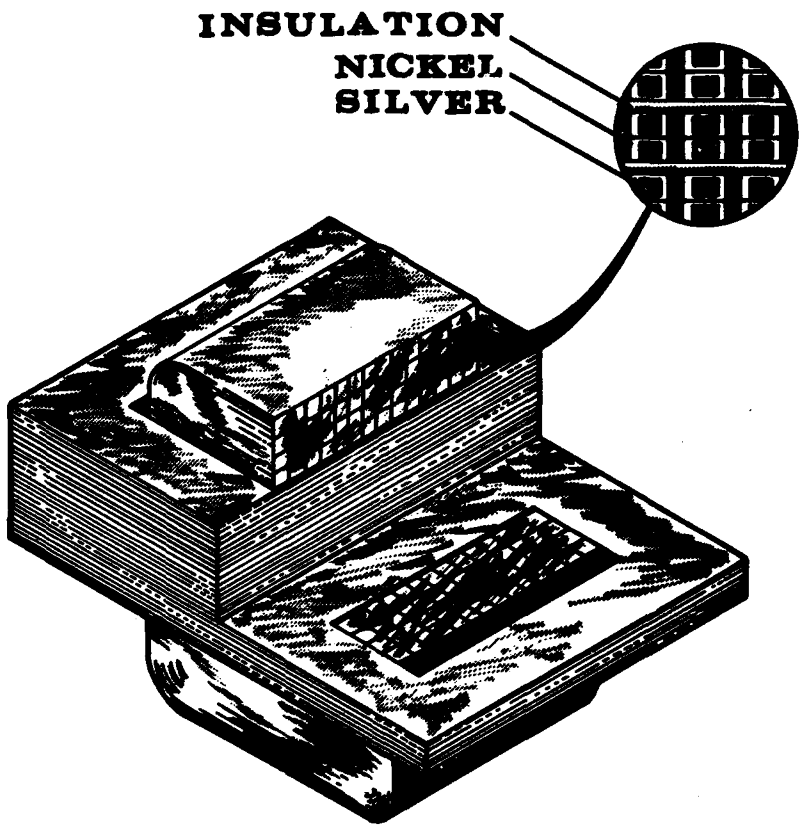


FIGURE 16. Conceptual View of 5 KVA Transformer

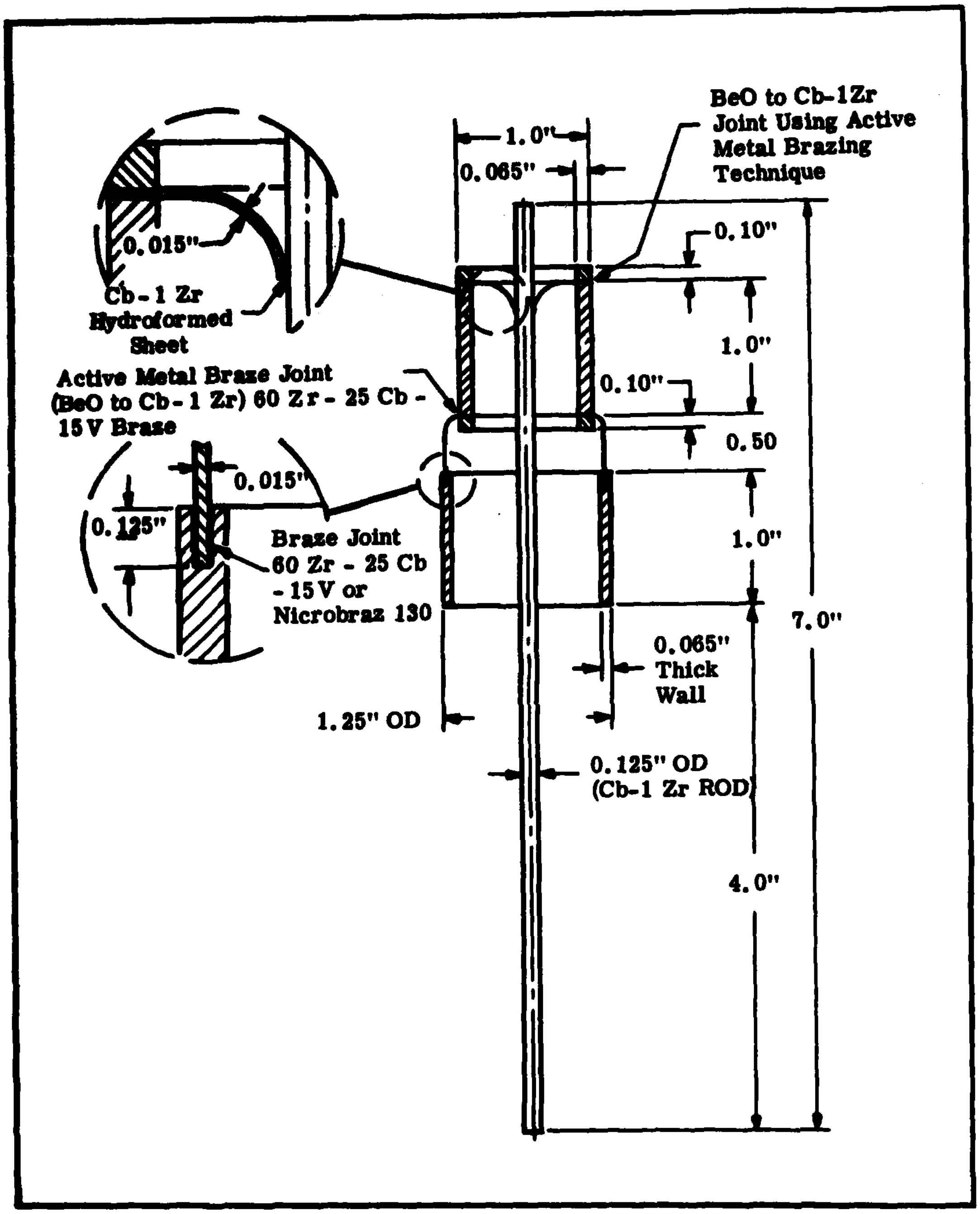


FIGURE 17. Ceramic to Metal Electrical Terminal Seal Configuration

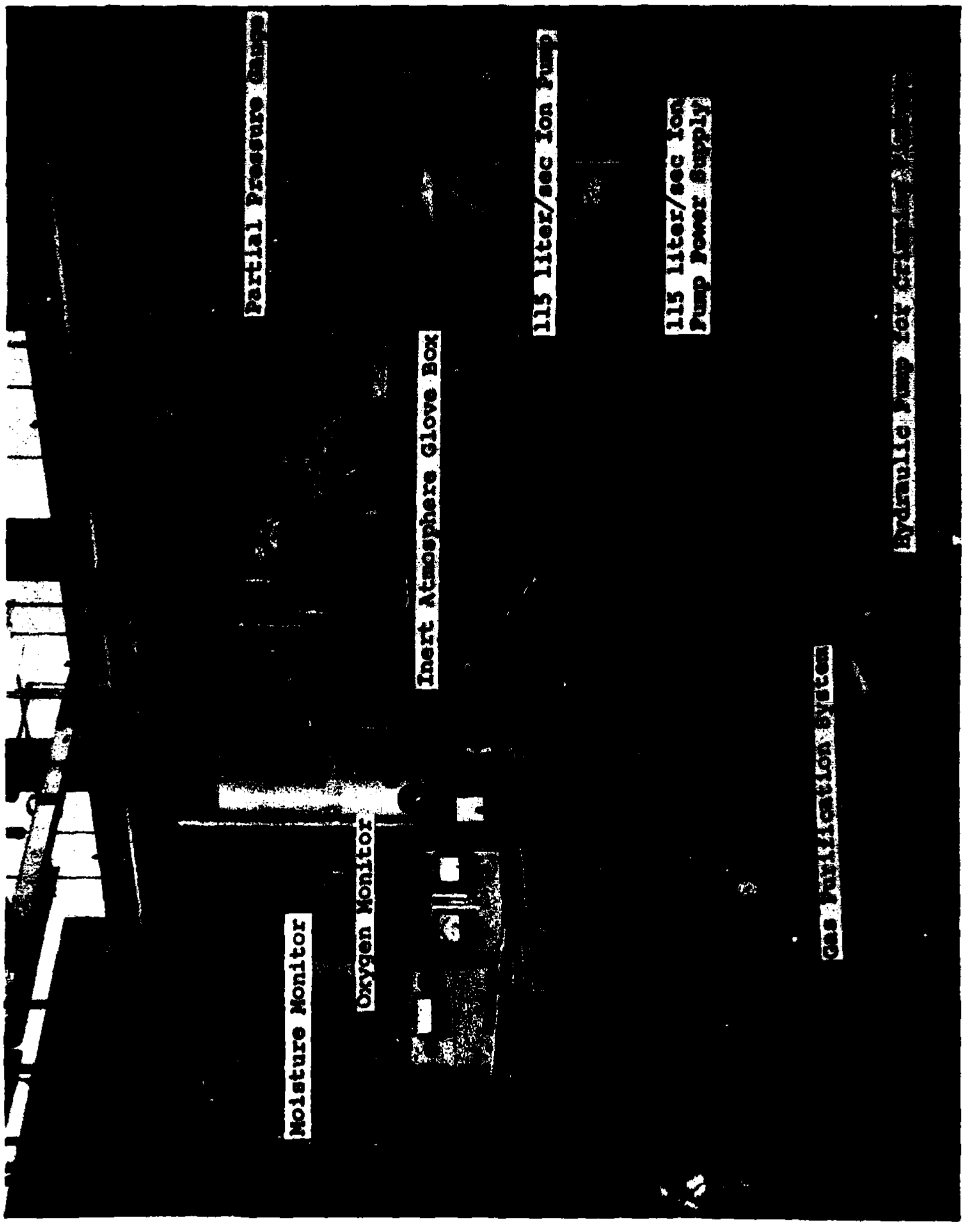


FIGURE 18. Inert Atmosphere Glove Box and Container Evacuation System

SECTION IV

PROGRAM FOR NEXT QUARTER

A. EVALUATION OF POTASSIUM EXPOSED MATERIALS

Continued work will be performed toward the evaluation of materials in potassium vapor.

1. <u>Potassium Vapor Exposure Specimens</u>

Potassium vapor exposure specimens will be obtained and subjected to pre-exposure tests. Hiperco 27 alloy test strips will be heat treated.

2. <u>Columbium-1% Zirconium Test Capsules</u>

Columbium-1% zirconium test capsules will be fabricated.

3. <u>Potassium Vapor Test Capsule Loadings</u>

Potassium vapor exposure capsules will be loaded with potassium, specimens added, and capsules sealed under reduced pressure.

4. <u>Test Container Loadings</u>

Potassium vapor exposure capsules will be loaded into test containers and placed in an oven for 600°C exposure.

5. <u>Rowland Rings</u>

Rowland rings of Hiperco 27 alloy will be heat treated.

6. <u>Active Metal Brazing</u>

Ceramic materials and metals will be joined by active metal brazing in the fabrication of the Rowland ring core box and feedthrough terminals.

7. <u>Core Box</u>

Components for the Rowland ring core box will be obtained, and core box parts fabricated.

8. Conductor Performance Test Container

Container for continuous measurement of conductor performance will be assembled.

B. PROCESSES AND TECHNIQUES FOR POTASSIUM VAPOR RESISTANT ELECTRICAL DEVICE FABRICATION

Work will be continued toward evaluating processes and techniques for fabricating potassium vapor resistant electrical devices. Ceramic metal interface test specimens will be prepared by plasma spray, R.F. sputtering, and combination techniques. Test capsules will be prepared. Potassium vapor exposure testing will be started.

1. Plasma Sprayed Insulation

Nickel clad silver conductors will be plasma sprayed with titanium hydride followed by 99% Al_2O_3 -1% MgO, and electrical characteristics evaluated. The same ceramic material will be plasma sprayed on magnetic materials and clad conductors having a sputtered titanium base layer.

2. R.F. Sputtered Materials

Specimens will be prepared with high purity alumina coatings for evaluation of electrical properties and potassium vapor resistance as an interlaminar insulation.

3. Alumina-Yttria Eutectic

Larger batches of alumina-yttria will be prepared from which modulus of rupture bars and high temperature electrical properties specimens will be fabricated.

4. Potassium Vapor Testing

Potassium vapor tests at 600°C for 200 hours will be performed on the following:

(a) Sapphire brazed to columbium -1% zirconium.

(b) Sapphire brazed to Kovar 22.

(c) Titanium binder plus 99.99% Al_2O_3 sputtered on Hiperco 27 alloy.

(d) Titanium binder plus 99.99% Al_2O_3 plasma arc sprayed on Hiperco 27 alloy.

C. FIVE KVA TRANSFORMER FABRICATION

Continued work will be performed toward the fabrication of transformer components and its test container.

1. Five KVA Transformer

Transformer E and I laminations will be procured. Clad conductors, coil forms, and interturn insulation will be ordered.

2. Ceramic Metal Feedthroughs

Ceramic metal feedthroughs will be obtained for use in conductor performance test and transformer containers.

SECTION V

REFERENCES

1. J. H. Stang et. al., "Compatability of Liquid Alkali Metals with Construction Materials." DMIC Report 227, April 15, 1966, page 58.

2. E. M. Levin et. al., "Phase Diagrams for Ceramists" The American Ceramic Society 1964, page 122.